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Market thickness, sunk costs, productivity, and the outsourcing decision: an empirical analysis of manufacturing firms in France

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Abstract. This paper presents an empirical analysis of outsourcing behaviour by French manufacturing industries. It focuses on the effects of market thickness, sunk costs, and the productivity of firms on the outsourcing decision. I estimate a dynamic probit model where outsourcing decision is linked to past outsourcing behaviour. The results show that outsourcing is a persistent strategy adopted by large firms and suggest the presence of significant sunk costs associated with outsourcing. The results also show that market thickness reduces search costs and enhances the establishment of outsourcing relationships. JEL classification: D23, L22

Densité du marché, coûts irrécupérables, productivité, et la décision de sous-traiter : une analyse empirique des entreprises manufacturières en France. Ce mémoire présente une analyse empirique du comportement de sous-traitance par les industries manufacturières françaises. On met l'accent sur les effets de l'épaisseur du marché, des coûts irrécupérables, et de la productivité des entreprises sur la décision de sous-traiter. On calibre un modèle probit dynamique où la décision de sous-traiter est liée au comportement de sous-traitance dans le passé. Les résultats montrent que la sous-traitance est une stratégie persistante adoptée par les grandes entreprises, et suggèrent que la présence de coûts irrécupérables importants est associée à la décision de sous-traiter. Les résultats montrent aussi que la densité du marché réduit les coûts de recherche, et renforce le développement de relations de sous-traitance.

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1. Introduction

'We live in an age of Outsourcing' stated Grossman and Helpman (2005). A growing share of firms delegates tasks of their production process to independent suppliers. Further, a wider range of tasks is contracted out. Nowadays, not only low-technology manufacturing tasks are outsourced but also services and even research and development (R&D) activities.

The outsourcing strategy corresponds to a 'Make or Buy' decision. A large body of the industrial organization literature has focused on the 'Make or Buy' strategy and on the boundaries of the firm. This literature puts forward the role of asset specificity, specific investments, transaction costs, and contract incompleteness (Williamson 1975, 1985; Grossman and Hart 1986).

While the traditional literature on outsourcing focuses on the relationship between two firms, a final good producers, and a supplier, new theoretical works try to consider the interactions between the organization decisions of firms.¹ For example, Grossman and Helpman (2002) develop a model of organization choice where vertical integration or outsourcing emerge as industry equilibria adopted by all firms. The model shows that firms are sensitive to market thickness, to the intensity of competition, and to the quality of search technologies.

Most of the existing empirical literature on outsourcing is based on the conclusions of the transaction costs and property rights theories (Lafontaine and Slade 2007; Hubbard 2008). The empirical evidence puts forward the determinant role of asset specificity and market conditions. A large share of this empirical literature considers the particular case of an industry or a firm. Very few existing studies consider a cross-section of industries or use firm-level data (Klein 2005; Joskow 2005). Case studies have the advantage of avoiding the problem of consistently measuring variables such as asset specificity or uncertainty across firms and industries. However, a limitation of case studies and cross-section analyses is their inability to control for firm's unobserved heterogeneity and for time effects. Empirical studies of the outsourcing decision at the firm-level have been presented by Masten (1984) for the aerospace industry, Girma and Görg (2004) for the United Kingdom (U.K.), Swenson (2004) for the United States (U.S.), Kimura (2001) and Tomiura (2005) for Japan, and Holl (2004) and Díaz-Mora and Triguero (2007) for Spain. Despite these contributions, evidence on the outsourcing strategy based on firm-level data is limited and many questions remain open for discussion and analysis.

This paper aims to investigate the outsourcing strategy using a large panel of firms in 16 French manufacturing industries. It emphasizes the role of new elements discussed by the theoretical literature (McLaren 2000; Grossman and Helpman 2002; Antras and Helpman 2004) such as the presence of sunk costs associated with outsourcing and the implications of market thickness on outsourcing.

¹ The organization decision stands for the choice between vertical integration and outsourcing.

Outsourcing requires significant costs related to the search and matching process, to monitoring, and to the enforcement of contracts. Because of the presence of these costs, outsourcing is expected to be a persistent strategy. Firms with previous outsourcing engagements are expected to maintain this strategy. Moreover, differences in firms' level of efficiency and scale will influence the outsourcing decision. Firms able to incur significant costs will self-select into outsourcing, while the others will vertically integrate. Regarding the impact of market thickness, I expect the size of the market to lower search costs and, hence, to favour the prevalence and viability of outsourcing (Grossman and Helpman 2002; McLaren 2000). These elements have been neglected by the empirical literature on outsourcing.

This paper contributes to the literature on outsourcing and market thickness by expanding and generalizing existing results. Pirrong (1993) and Hubbard (2001) present two related but slightly different empirical studies of the role of market thickness. Both papers focus on the choice between long-term contracts and spot-market transactions and provide evidence based on a single industry: bulk shipping in the case of Pirrong (1993) and trucking in the case of Hubbard (2001). Both papers show that market thickness reduces the reliance on long-term contracts and favours the establishment of spot-market outsourcing relationships. Swenson (2007) considers the dynamic nature of outsourcing relations and the role of market thickness in the case of international outsourcing and more specifically the location choice of overseas assembly programs by U.S. firms with a specific focus on the role of competition. Swenson (2007) uses data on the country-industry level and provides evidence on the persistence of outsourcing, and a significant role of market thickness. Ono (2007) also considers market thickness as a determinant of the outsourcing of business services and shows a positive and significant effect. While Ono (2007) uses a cross-section of firms and focuses on business services, this paper uses panel data and considers several types of outsourcing. The dynamic aspect of the outsourcing behaviour has been considered by very few studies and these studies fail to present conclusive results.

This paper is based on the annual firm survey, 'Enquête Annuelle d'Entreprises (EAE)' realized by the French Ministry of Industry, which covers all manufacturing firms, located in the French metropolitan territory, with more than 20 employees for the period 1990–2001. This survey provides data on the production activity, the outsourcing activity, and the characteristics of firms. The main focus of this paper is the firm's decision to engage in outsourcing relationships. The main results derive from the estimation of a dynamic probit model of the outsourcing decision. I choose to analyze the outsourcing decision, not the value of the contracted-out production, because the theoretical literature focuses essentially on the choice between vertical integration and outsourcing and does not offer theoretical predictions regarding the value of the contracted-out activity. Moreover the 'EAE' survey provides information on total contracted-out activities, not on specific outsourcing transactions, which makes the analysis of the value of outsourcing more complicated. However, since the data on the value

of the contracted-out activity are available, I also estimate a Tobit model that explains the intensity of outsourcing activity.

The empirical analysis faces two serious problems: the first is related to the endogeneity of certain regressors, especially productivity, while the second is related to unobserved contracts duration. A positive correlation between present and past outsourcing decisions may simply reflect the presence of long-term contracts and is not necessarily a persistent behaviour due to significant fixed costs. I present robustness checks that aim to overcome these limitations.

The results provide evidence on the persistence of the outsourcing strategy. Past outsourcing activity raises the probability of current outsourcing. However, as mentioned earlier, these findings need to be interpreted with care. The results also show a significant correlation between firm size and the outsourcing activity. Finally, the results show that the size of the market favours the establishment of outsourcing relationships.

2. Determinants of the outsourcing strategy

The purpose of this paper is the empirical analysis of the outsourcing decision with a special emphasis on sunk costs, the characteristics of firms, and market thickness. Recent theoretical contributions to the literature on outsourcing have put forward the role of these elements, and the aim of the paper is to empirically investigate these theoretical contributions.

The theoretical predictions analyzed in this paper are based on theoretical models like those by Grossman and Helpman (2002), McLaren (2000), and Antras and Helpman (2004). These models put forward the role of firms' characteristics and the size of the market in determining the choice between 'Make' or 'Buy' strategies. They have expanded the traditional framework of the transaction costs and property rights theories to allow a determinant role for firm heterogeneity and to explore the role of interactions between firms in determining the equilibrium outcome of the market. The remainder of this section discusses the predictions related to the three points of interest of this paper; market thickness, costs of outsourcing, and firms' characteristics.

2.1. Market thickness

The transaction costs and property rights theories of the firm, traditionally have considered the vertical relation between two individual firms: a buyer and a supplier. Both theories have neglected the possibility that the organization mode adopted by one buyer might influence the organization choices made by other buyers within the same market. Recent theoretical contributions, such as those by Grossman and Helpman (2002) and McLaren (2000), contribute to these theories by allowing for the interaction between buyers' choices and designing

a framework where outsourcing and vertical integration emerge as endogenous industry equilibria.

The McLaren (2000) model considers an industry with a certain number of final good producers, each requiring a specialized input. The inputs are produced by specialized suppliers. Each pair of final good producer and specialized supplier has two possibilities of organizing their relationship: outsourcing (market transactions) or vertical integration. The novelty of the McLaren (2000) model is that the organizational choice of each pair of firms depends on the choice of the other pairs in the industry. Each specialized supplier has the outside option of selling the input to another final good producer. This outside option increases with the number of non-integrated final good producers in the market. The equilibrium price received by a specialized supplier depends on its ex post bargaining power and increases with its outside option. As the number of non-integrated final good producers grows (a thicker downstream market), the outside option of the specialized supplier as well as the attractiveness of market transactions increase.

Grossman and Helpman (2002) offer a different view of the link between market thickness and the vertical integration decision. In their model, non-integrated buyers need to search for a suitable supplier and incur fixed search costs. Market thickness will affect the viability and the prevalence of a mode of organization through its impact on search costs. Grossman and Helpman (2002) show that, in the presence of increasing returns to matching, the viability and prevalence of outsourcing will increase with the size of the industry and of the economy: 'Outsourcing is more likely to be viable in large industries and in large economies, due to the benefits of having a 'thicker' market. This might help to explain the greater specialization of firms in New York City compared with Pittsburgh, and perhaps in the United States compared with elsewhere in the world' (4).

2.2. The costs of contractual relationships

The model of Grossman and Helpman (2002) stresses the significance of fixed costs associated with outsourcing. These costs are needed for finding a suitable partner and establishing contracts. Additional costs that depend on the extent and nature of the relationship are also significant, such as the costs of enforcing contracts, monitoring the partner's work, and communicating and exchanging technology with the partner. Some of these costs, related to the search and matching process, are sunk. Others, related to monitoring and communication with partners, may be subject to 'learning-by-doing' effects. In this case, the accumulated experience of a buyer in dealing with its suppliers will reduce the costs of future transactions with these suppliers or with new partners. The nature of these organizational costs suggests that outsourcing is likely to be a persistent strategy. Buyers will want to avoid incurring the same costs repeatedly, and they will also want to benefit from their accumulated experience.

In order to assess the significance of the costs associated with outsourcing and the persistence of the outsourcing strategy I link the current outsourcing decision

to past outsourcing behaviour. I estimate a discrete choice model (probit) where the current outsourcing status depends on the outsourcing status in the previous year.²

2.3. *Firm's characteristics*

The presence of significant fixed organizational costs raises the question of the role of firm's characteristics. The literature on exports (Melitz 2003; Bernard and Jensen 2004) and more recently on offshoring (Antras and Helpman 2004; Grossman and Helpman 2004) argues that, in the presence of fixed costs, differences in firm's characteristics need to be taken into account. Within an industry, firms display several heterogeneous characteristics, such as differences in scale, intensity in human capital, and productivity. This strand of the literature usually takes productivity as a measure of a firm's efficiency and shows that the more productive firms self-select into costly activities: exporting in the case of Melitz (2003) and Bernard and Jensen (2004) and foreign direct investment (FDI) in the case of Helpman, Melitz, and Yeaple (2004).

The literature on outsourcing presents different assumptions on the hierarchy of fixed costs between vertical integration and outsourcing and different predictions regarding the self-selection of firms into the different organization modes. For example, Antras and Helpman (2004) assume that fixed costs are higher in the case of vertical integration and predict that most productive firms will vertically integrate. Grossman, Helpman, and Szeidl (2005) assume the opposite ranking of fixed costs and predict that most productive firms will outsource. If fixed costs of organization are higher under outsourcing, I expect productivity to raise the probability of outsourcing.³ Furthermore, if the buyer is a large firm, it can spread the fixed costs on a larger number of produced units. The scale of the buyer is therefore an additional determinant of the outsourcing decision. However, outsourcing gives small buyers the opportunity to specialize and to benefit from scale effects. The impact of scale on the outsourcing decision is thus ambiguous. Both Girma and Görg (2004) and Díaz-Mora and Triguero (2007) have analyzed the impact of scale on outsourcing. While Girma and Görg (2004) show positive and significant effects of scale on outsourcing, the study by Díaz-Mora and Triguero (2007) has found no significant effects.

2.4. *Additional determinants of outsourcing*

In addition to contractual costs, buyers' characteristics, and market thickness, I consider other determinants of the outsourcing strategy. I take into account the average wage of the buyer. I assume that a higher average wage increases

2 This methodology is similar to the one applied by Roberts and Tybout (1997) and Bernard and Jensen (2004) to analyze the export decision and to test the presence of sunk costs related to the export behaviour.

3 Even when fixed costs are lower under vertical integration, some firms may still prefer outsourcing in order to limit variable costs.

the probability of outsourcing for two reasons. First, average wage may be an indicator of the firm's labour quality and thus of the firm's productivity. Second, by contracting-out a certain amount of production or a certain set of tasks, buyers may be able to reduce their variable costs (Abraham and Taylor 1996).⁴ Buyers paying relatively high wages may therefore be more sensitive to the possibility of reducing their wage bill and are, thus, more inclined to contract-out production.

I also consider the degree of diversification of the buyer's production. Some firms are multi-product firms and report the production of several goods (following the 4-digit industry classification). The diversification of the production activity may affect the outsourcing strategy in several ways. On the one hand, firms that produce a wide range of goods may be less sensitive to the gains from economies of scale and to the specialization opportunities offered by outsourcing. On the other hand, outsourcing provides firms with a certain flexibility in terms of the production of goods and of the acquisition of inputs, which may be attractive to buyers producing several goods.

I include two indicators of the buyer's ownership; affiliation to a group and affiliation to a foreign group. Affiliation to a group may provide the buyer with a network of suppliers and alleviate financial constraints that may hinder outsourcing relationships. The nationality of the group (domestic vs. foreign) may also be important, since foreign groups may not have sufficient links within the domestic economy to promote outsourcing activities. Finally, I add a variable representing the intensity of competition pressures faced by the buyer. Buyers facing tougher competition may wish to reduce their variable costs by contracting-out costly activities. Grossman and Helpman (2002) consider the implications of the degree of competition on an industry's equilibrium mode of organization and show that higher levels of competition may favour either mode of organization depending on the bargaining power and efficiency advantage of specialized suppliers.

3. The empirical analysis

The empirical strategy consists of estimating the following dynamic binary-choice model:⁵

$$Outsourcing_{it} = \begin{cases} 1 & \text{if } \alpha + \beta X_{it} + \gamma Z_{j(i)t} + \theta Outsourcing_{it-1} + \epsilon_{it} > 0 \\ 0 & \text{otherwise.} \end{cases} \quad (1)$$

where $Outsourcing_{it}$ represents the outsourcing status of firm i (in industry j) at time t , X_{it} is the vector of firm characteristics, $Z_{j(i)t}$ is the vector of time varying industry j characteristics, and θ represents the persistence of the outsourcing

4 This holds if the production is contracted-out to a lower-wage supplier or to a specialized supplier that has the capacity to produce more efficiently and at a lower cost.

5 Since the focus of the paper is on the outsourcing decision at the buyer's level, hereinafter the term *firm* will be used to refer to the buyer.

strategy.⁶ α is a constant term and β , γ , and θ are vectors of coefficients to be estimated.

To avoid potential simultaneity problems between the outsourcing status and the independent variables, all independent variables are lagged one year. Hence, I estimate the following equation:

$$Outsourcing_{it} = \alpha + \beta X_{it-1} + \gamma Z_{j(i)t-1} + \theta Outsourcing_{it-1} + \epsilon_{it}. \quad (2)$$

The estimation of equation (2) raises several econometric issues, especially the identification of the coefficient on the lagged dependent variable. The persistence in the outsourcing behaviour, as in any binary choice setting, can arise from firm heterogeneity and serial correlation in the error term ϵ_{it} or from state dependence. Equation (2) controls for a set of firm characteristics that reflect firm heterogeneity, but other firm fixed effects may remain unobservable. If these firm unobservable characteristics affect the outsourcing decision and if they have a permanent aspect, their presence will induce a serial correlation in the error term. In the presence of firm heterogeneity, the error term is assumed to take the following form: $\epsilon_{it} = \sigma \mu_i + v_{it}$, where μ_i is a firm-specific effect and v_{it} follows the distribution $N(0, \sigma_v^2)$. The omission of these unobserved variables will attribute the persistence in the outsourcing status to the presence of sunk costs and will lead to an overestimated coefficient on the lagged dependent variable. This corresponds to the ‘spurious state-dependence’ problem discussed by Heckman (1981a, c). The estimation of a fixed-effects model is usually adopted to control for unobserved firm heterogeneity. But in the case of dynamic binary choice models with a limited time period, the use of fixed effects will lead to an inconsistent estimation (Heckman 1981b). Furthermore, the estimation of a dynamic binary choice model in the presence of unobserved heterogeneity needs to take account of the ‘initial conditions problem.’ The first observation: $Outsourcing_{i1}$ can have an impact on the entire path of outcomes and cannot be treated as an exogenous determinant of $Outsourcing_{it}$ (Heckman 1981b; Wooldridge 2001; Greene 2003). Heckman (1981b) presents a solution to the ‘initial conditions problem.’ It proposes to approximate the reduced-form equation for the dependent variable’s initial value by a probit function depending on pre-sample exogenous information:

$$Outsourcing_{i1} = \alpha_1 + \beta_1 X_{i0} + \gamma_1 Z_{j(i)0} + \eta_i, \quad (3)$$

where $\eta_i = \tau \mu_i + v_{i1}$ is correlated with μ_i , when τ is different from zero,⁷ and uncorrelated with v_{it} for $t \geq 2$. Heckman (1981b) suggests the following joint probability of $(Outsourcing_{i1} \dots Outsourcing_{it})$ for firm i given μ_i :

6 $Z_{j(i)t}$ includes a firm subscript because the market thickness variables vary at the firm level.

7 In the case where $\tau = 0$ initial conditions are considered exogenous.

$$\Phi[(\alpha_1 + \beta_1 X_{i0} + \gamma_1 Z_{j(i)0} + \tau \mu_i)(2Y_{i1} - 1)] \\ \times \prod_{t=2}^T \Phi[(\alpha + \beta X_{it-1} + \gamma Z_{j(i)t-1} + \theta Y_{it-1} + \sigma \mu_i)(2Y_{it} - 1)], \quad (4)$$

where Φ is the standard normal cumulative distribution function and Y represents the dependent variable (the outsourcing status).

The Heckman (1981b) model is estimated with a random parameter estimator (Arulampalam and Stewart 2009) in the following form:

$$\text{Outsourcing}_{it} = \beta X_{it-1} + \beta_1 X_{i0} + \gamma Z_{j(i)t-1} + \gamma_1 Z_{j(i)0} + \theta \text{Outsourcing}_{it-1} \\ + \phi d_{it} + \varphi f_{it} + v_{it} + \sigma f_{it} \mu_i + \tau d_{it} \mu_i, \quad (5)$$

where d_{it} is equal to one in period one and equal to zero in all periods > 1 , $f_{it} = 1 - d_{it}$ is equal to one in all periods > 1 and zero in period one, the set of regressors X_{it-1} and Z_{ijt-1} are set to zero in period one while the set of regressors X_{i0} and Z_{ij0} is set to zero in all periods except period one. d_{it} and f_{it} are two random parameters that are assumed to take the following form: $d_{it} = d^0 + \varsigma_d \vartheta_{di}$ and $f_{it} = f^0 + \varsigma_f \vartheta_{fi}$. d^0 and f^0 are the means of the two random parameters, ς_d and ς_f are two scale parameters, which in the context of this model correspond to the standard deviation of the random parameters, and ϑ_{di} and ϑ_{fi} are random draws from a normal distribution. Equation (5) is estimated by maximum simulated likelihood.⁸

All specifications include a full set of 2-digit industry fixed effects and time fixed effects. Industry fixed effects control for industry specific features that are likely to influence, positively or negatively, the outsourcing decision at the firm level. These industry features may reflect, for example, the degree of economies of scale experienced by firms within a certain industry due to the nature of their production technology. Outsourcing allows a higher degree of specialization and offers firms the opportunity to allocate their resources to their core activities and increase the scale of their production. The sensitivity of firms to the benefit of specialization increases with the degree of economies of scale. Industry features may also reflect the degree of asset specificity, within a certain industry, that would determine the willingness of firms to engage in outsourcing agreements. Time fixed effects control for shocks or changes that would have an impact, positively or negatively, on the outsourcing decision by firms. These shocks include, for example, changes to regulations or to the degree of contract incompleteness that would make it easier or harder for firms to contract-out production. The error term controls for firm-specific, positive or negative, shocks that may play a determinant role in the outsourcing decision. For example, a positive, firm-specific,

8 The estimation is robust to the choice of number of draws as well as to the use of a Halton sequence instead of a random draw. I use a Halton sequence because it has the advantage of reducing the estimation time.

demand shock in a certain year may induce the firm to engage in outsourcing relationships in order to complement internal capacity. A change in the management of the firm may also favour or disfavour contractual relationships.

As mentioned in the introduction, I also estimate a model that links the intensity of the outsourcing activity to firm and industry characteristics:

$$\text{Outsourcing Intensity}_{it} = \alpha' + \beta' X_{it-1} + \gamma' Z_{ijt-1} + \mu'_{it}, \quad (6)$$

where *Outsourcing Intensity*_{it} is measured as the ratio of the contracted-out activity over the total use of inputs by firm *i* at time *t*, and the total use of inputs is measured as the sum of purchased materials, purchased merchandise, and contracted-out activity. The estimation of equation (6) needs to take into account the censored nature of the *Outsourcing Intensity*_{it} variable. All specifications include 2-digit industry fixed effects and time fixed effects.

A Tobit model is the traditional approach used to deal with censored data (Wooldridge 2001). The Tobit model combines the probabilistic and ordinary regression with the method of maximum likelihood (Amemiya 1973; Wooldridge 2001). Some authors (e.g., Cragg 1971) criticize the Tobit model for making the strong assumption that censored and uncensored values are generated by the same probability mechanism. They suggest an alternative two-part model that estimates in one part the probability of the dependent variable being positive and use linear regression to explain the positive values of the dependent variable (Greene 2003). A comparison of the estimated log-likelihood of the Tobit model with the sum of the log-likelihoods from the two-part model shows that the Tobit model provides a better fit for the data.⁹

In this empirical analysis I follow the assumption of the Grossman and Helpman (2002) model and consider that firms compete in a monopolistic competition setting. The 'EAE' survey covers a large number of firms and, despite excluding the very small firms (less than 20 employees), the average scale (147 employees), and the average market share in each 4-digit industry (1.4%), does not suggest an oligopolistic structure. Certain industries within the French economy may have an oligopolistic structure – the car industry or other transport industry, for example. However, firms enter their industry at different points in time and engage in their first outsourcing relationship at very different points in time. Moreover, the contracted-out activity by each firm may refer to different types of input or service in comparison with the other firms in the same industry. Within a narrowly defined industry firms may be competing for the services of certain suppliers and the outsourcing of certain inputs or services may be a strategic behaviour, but the totality of the outsourcing activity aggregated over all transactions is unlikely to

9 The results of the Tobit model are consistent with those from the two-part model. They are also consistent with the estimation of a selection model. The selection model has an advantage over the two-part model because it allows dependence between the two equations (the probability equation and the linear equation) of the model. Results from the two-part model and the selection model are available upon request.

be strategic or to depend on other firms' outsourcing activities. For these reasons it is more reasonable to assume that firms' individual outsourcing decisions (on status and intensity) are independent.

4. Data description

The empirical analysis is based on a data set derived from the annual firm survey, 'Enquête Annuelle d'Entreprises' (EAE), realized by the French Ministry of Industry. The EAE survey covers all firms with more than 20 employees in 16, 2-digit, manufacturing industries for the period 1990–2001. The data set is an unbalanced panel with a number of firms per year varying from 21,292 firms in 1990 to 18,369 firms in 2001. The EAE survey provides, among others, data on the productive activity of firms: output, exports, number of employees, stock of fixed capital, investment, value added, use of intermediate inputs, the wage bill, and the outsourcing activity. Each firm reports the amount of activity (material inputs or services) contracted-out to non-integrated suppliers. The availability of data on the contracted-out activity allows the construction of the two variables of interest: the outsourcing status and the outsourcing intensity. The outsourcing status is a dummy variable that takes the value one if the firm is engaged in outsourcing relationships at time t and zero otherwise. The outsourcing intensity is measured as the share of contracted-out activity in the total use of inputs by the firm.¹⁰ The contracted-out activity is defined according to the French accounting system and corresponds to 'the outsourcing of goods and services directly integrated in the cycle of production of the firm.' This definition of outsourcing implies the presence of contractual agreements between buyers and suppliers and the presence of collaboration and coordination in the design and the production of the contracted-out goods and services.¹¹ The data set allows the identification of the outsourcing of services.¹² It also allows the distinction of a narrow definition of outsourcing: industrial outsourcing. Industrial outsourcing corresponds to contracted-out activities (goods and services) where the buyer is the legal owner of the contracted-out goods or services and has the technical and commercial responsibilities of the contracted-out goods or services. Industrial outsourcing also implies a precise description of the tasks related to the conception and the production of the contracted-out goods or services. Using this information, I create four additional variables: the outsourcing of services status, the outsourcing of services intensity, the industrial outsourcing status and the

10 The total use of inputs corresponds to the sum of purchased materials, purchased merchandise, and contracted-out activity.

11 This definition excludes the purchase of materials even if the transaction is covered by contractual agreements.

12 Total outsourcing is decomposed into different accounts, following the French accounting system. One of these accounts is the outsourcing of services. The remaining accounts are 'general outsourcing,' the 'outsourcing of equipments and works,' and 'outsourcing in other accounts.' However, the separation of these three different accounts is not possible in all years.

industrial outsourcing intensity. The outsourcing of services (industrial outsourcing) status is a dummy variable that takes the value one if the firm reports positive amounts of contracted-out services (industrial outsourcing) and zero otherwise. The outsourcing of services (industrial outsourcing) intensity is measured as the share of the outsourcing of services (industrial outsourcing) in the total use of inputs.¹³

One of the main focuses of this paper is the presence of significant costs related to the outsourcing activity and the role of productivity and scale in the decision to engage in outsourcing agreements. Scale is measured by the number of employees. Total factor productivity (TFP) is measured as a productivity index following the methodology by Caves, Christensen, and Diewert (1982). The productivity index measures each firm's output and inputs as deviations from a single reference point. I follow Aw, Chen, and Roberts (2001) and adopt as reference point a hypothetical firm whose input revenue shares are equal to the mean revenue shares over all observations within a 2-digit industry and whose input levels are equal to the mean of the log of the inputs over all observations within a 2-digit industry. I use a separate reference point for each 2-digit industry and in each cross-section of the data and chain-link the reference points over time to create the productivity index:

$$\begin{aligned} \ln TFP_{ijt} = & (\ln Y_{ijt} - \overline{\ln Y_{jt}}) + \sum_{s=2}^t \overline{\ln Y_{js}} - \overline{\ln Y_{js-1}} \\ & - \left[\sum_{x=1}^n \frac{1}{2} (S_{xijt} + \overline{S_{xjt}}) (\ln E_{xijt} - \overline{\ln E_{xjt}}) \right. \\ & \left. + \sum_{s=2}^t \sum_{x=1}^n \frac{1}{2} (\overline{S_{xjs}} + \overline{S_{xjs-1}}) (\overline{\ln E_{xjs}} - \overline{\ln E_{xjs-1}}) \right], \end{aligned} \quad (7)$$

where Y_{ijt} is the output of firm i , in industry j , at time t , E_{xijt} represents the set of inputs used by the firm, and S_{xijt} measures the share of the firm's expenditure on input E_{xijt} in total revenue. $\overline{\ln Y_{jt}}$, $\overline{\ln E_{xjt}}$, and $\overline{S_{xjt}}$ are the means of firm-level variables within industry j at time t .

Another matter of interest for this empirical analysis is the impact of market thickness on the outsourcing decision. I create several measures of market thickness to test the robustness of the implications of market thickness. The first variable, 'Market Thickness,' is measured as the total number of employees of

13 It is important to note that, industrial outsourcing, refers to the contractual and legal natures of the relationship between the firm and the supplier but not to the type of the subcontracted activities. Industrial outsourcing may represent the outsourcing of goods and or services. In this sense, the total outsourcing variable is not equal to the sum of the outsourcing of services and of industrial outsourcing.

the firm's 4-digit industry within the same region that the firm is located:¹⁴

$$\text{Market Thickness}_{ijt} = \sum_{k \in jrt} \text{Employment}_{kt}, \quad (8)$$

where k represents firms (different from firm i), j represents the industry and r the region. The second variable, 'Industry Size,' is measured as the total number of employees in the same 4-digit industry as firm i , from which I exclude the employment of firm i . This variable is analogous to the 'Market Thickness' variable but it does not take account of the regional dimension. The third variable, 'Relative Size Region,' represents the relative size of the firm's 4-digit industry with respect to the size of the manufacturing industry within the same region. It is measured as the ratio of the total number of employees in the firm's 4-digit industry and within the same region (except for the employment of firm i) over the total number of employees in all 16 manufacturing industries within the same region. The fourth variable, 'Relative Size,' represents the relative size of the firm's 4-digit industry with respect to the size of the manufacturing industry in France. It is measured as the ratio of the total number of employees in the firm's 4-digit industry (except for the employment of firm i) over the total number of employees in all 16 manufacturing industries. The fifth variable, 'Agglomeration,' is the product of two dummy variables: the first takes the value one if the firm belongs to a 4-digit industry that is geographically agglomerated and zero otherwise, and the second takes the value one if the firm is located within the region with the highest share of employment of the firm's 4-digit industry.¹⁵

I also include additional controls at the firm and industry levels. Four firm-level control variables are considered: the average wage, measured as the ratio of the wage bill over the number of employees, the firm's affiliation to a group, the nationality of the group (foreign vs. domestic), and a product diversification index. Information on group affiliation is from the Financial Liaisons 'LIFI' survey. The 'LIFI' survey is realized annually by the French national statistic office INSEE. It covers financial links between firms, identifies the firm's affiliation to a group, and gives the identity of the parent company as well as its country of origin. The LIFI survey allows the creation of two dummy variables, the first one, 'group,' takes the value one if the firm is controlled by a parent company and zero otherwise, while the second one, 'foreign,' takes the value one if the parent company is foreign and zero otherwise. The variable, 'diversification index', measures the extent of the diversification of the firm's production. The firm annual survey reports if the firms are multi-product or not and reports the

14 The geographical classification follows the administrative decomposition of France into administrative departments. According to this classification, metropolitan France accounts for 96 regions.

15 The geographic concentration index corresponds to the one defined by Ellison and Glaeser (1997). The level of aggregation is the 4-digit French classification for industries, while the geographical unit is the department. Ellison and Glaeser (1997) consider that an industry is geographically agglomerated if its concentration index is higher than 0.05.

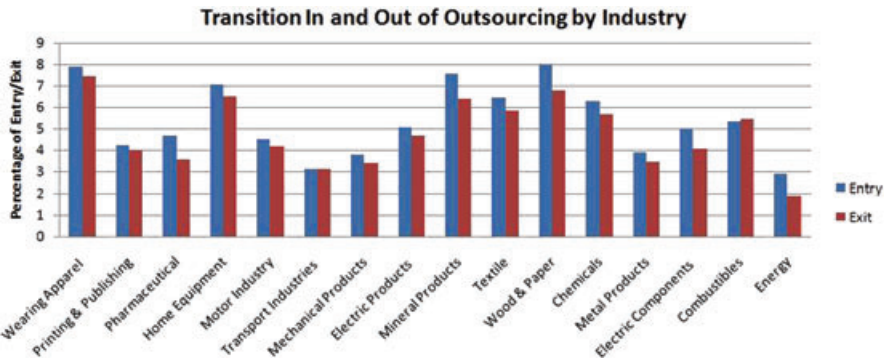


FIGURE 1 Transition in and out of outsourcing

production of each product according to the 4-digit industry classification. The diversification variable corresponds to the inverse of a Herfindahl index of the shares of each product in the total output of the firm.

At the industry level I control for the degree of competition. I follow Aghion et al. (2005) and measure product market competition as follows:

$$Competition_{jt} = 1 - \frac{1}{N_{jt}} \sum_{i \in j} \frac{Operating\ Profits_{it}}{Sales_{it}}, \tag{9}$$

where j represents a 4-digit industry. A value of one of the competition variable indicates perfect competition, while values below one indicate a certain degree of market power. Data on operating profits and sales are extracted from the EAE survey.¹⁶

A look at the data shows that transition in and out of outsourcing is relatively weak. Figure 1 presents the percentage of firms beginning to outsource as well as the percentage of firms quitting the outsourcing strategy in each 2-digit industry. The transition in and out of outsourcing is limited, but certain differences across industries do exist. The entry and exit percentages vary from around 8% in the wearing apparel and wood and paper industries to around 2% in the energy sector. Table 1 presents the percentage of firms engaged in outsourcing conditional on a positive outsourcing activity in the past. Table 1 shows that, in the case of total outsourcing, 94% of firms that outsource at time $t - 1$ outsource also at time t . This percentage decreases slightly with the time period but remains significantly high.

Table 2 presents descriptive statistics of all variables and table 3 presents a comparison¹⁷ between outsourcing and non-outsourcing firms in each 2-digit industry. Table 3 shows that within each industry a large share of firms (75% to 90%) are engaged in outsourcing relationships. The intensity of outsourcing

16 A detailed definition of the variables is presented in the appendix.

17 This comparison is based on a mean difference test.

TABLE 1
Probability of outsourcing conditional on positive past outsourcing activity

	Outsourcing	Industrial	Services
$t - 1$	94.19	92.61	89.84
$t - 2$	93.3	90.96	87.48
$t - 3$	92.84	90.18	85.9
$t - 4$	92.41	89.45	84.52
$t - 5$	92.02	88.74	82.99
$t - 6$	91.46	88.04	81.43
$t - 7$	91.63	87.58	80.08
$t - 8$	91.57	87.29	79.36
$t - 9$	91.64	87.15	78.7
$t - 10$	91.78	87.06	78.34
$t - 11$	91.84	86.4	77.64

TABLE 2
Descriptive statistics

Variable	No. of obs.	Mean	Stand. dev.	Between firms	Within firms
Outsourcing	207131	0.854	0.353	0.299	0.24
Outsourcing of Services	181900	0.54	0.498	0.43	0.275
Industrial Outsourcing	181955	0.763	0.424	0.362	0.271
Outsourcing Intensity	205985	0.2	0.234	0.22	0.11
Services Intensity	181097	0.087	0.2	0.9	0.1
Industrial Intensity	181097	0.16	0.2	0.9	0.1
Scale	207131	149.4	1196.2	843.34	260.29
Average Wage	207131	137.4	45.1	42.27	21.88
Productivity	202528	1.5	0.17	0.16	0.07
Diversification Index	234501	1.25	0.479	0.392	0.238
Group	234507	0.258	0.438	0.367	0.218
Foreign	234507	0.054	0.226	0.163	0.146
Competition	234489	0.094	0.024	0.023	0.009
Market Thickness	207131	1145.06	3181.84	3097.31	951.31
Industry Size	207131	22916.05	20083.74	19832.47	3847.55
Relative Size	207131	0.008	0.007	0.006	0.001
Relative Size-Region	207131	0.019	0.035	0.033	0.009
Agglomeration	234507	0.06	0.236	0.218	0.09

NOTE: All monetary variables are expressed in thousands of French francs and deflated using industry-level price indices.

varies across industries; it is only 8.8% in the wood and paper industry and 11% in the chemicals industry, but 36% in the printing and publishing industry and 40% in the energy sector.¹⁸ Table 3 shows that outsourcing firms are significantly larger than non-outsourcing firms in all industries and more productive in most industries.

18 It is important to note that the annual firm survey covers relatively large firms. It covers around 20% of the number of manufacturing firms, small firms being very numerous. However, it covers around 80% of the employment in the manufacturing industries. Thus, the share of firms engaged in outsourcing is overestimated, since, as shown in the next section, scale is an important determinant of the outsourcing strategy.

TABLE 3
Comparison between outsourcing and non-outsourcing firms: a sectoral analysis

Industry	Total no. of obs.	Percentage share of outsourcing firms	Average outsourcing intensity of outsourcing firms	Average productivity		Average number of employees	
				Non-outsourcing firms	outsourcing firms	Non-outsourcing firms	Outsourcing firms
Wearing and Apparel	16031	76.36	29	-0.07	0.08	59	90
Printing and Publishing	18055	91.37	37	0.06	0.09	54	82
Pharmaceutical	5053	86.78	14.8	0.04	0.042	101	316
Home Equipment	13369	80.55	15	0.12	0.15	62.9	140
Motor Industry	4840	89.24	12.5	0.18	0.08	95	718
Other Transport Industries	2562	93.17	37.5	0.1	0.15	78.9	490
Mechanical Equipment	34683	91.48	27.6	0.04	0.1	50.2	97.4
Electric and							
Electronic Equipment	10096	86.71	21.9	0.17	0.23	58.2	228.4
Mineral Products	12518	74.78	18.1	0.002	0.02	57.1	148.5
Textile	12735	79.42	20.5	0.03	0.11	63.9	98
Wood and Paper	12867	75.69	8.9	0.13	0.13	67.3	120.5
Chemicals	19598	81.93	11.7	0.11	0.12	71.9	199.5
Metal Industries	34777	91.3	27.5	0.03	0.09	50.8	105.06
Electric and							
Electronic Components	7461	88.54	15.8	0.2	0.21	89	239.5
Combustibles	718	79.25	30.4	0.16	0.34	131.2	678.05
Energy ²⁷	1768	91.97	42.6	-0.37	0.13	106.34	1398.5

NOTES: All the differences between outsourcing and non-outsourcing firms are statistically significant at the 1% level, except in the case of the scale variable, the difference in productivity are not always significant. The statistical test for differences between the mean values of the two groups is a t-test, not assuming equal variances for the groups.

TABLE 4
Determinants of the outsourcing strategy: marginal effects

	Outsourcing	Industrial	Services
Outsourcing ($t - 1$)	0.2*** (0.05)	0.33*** (0.08)	0.4*** (0.03)
TFP	0.011*** (0.01)	0.03*** (0.008)	0.05*** (0.006)
Scale	0.02*** (0.01)	0.02*** (0.006)	0.05*** (0.004)
Average Wage	0.012*** (0.008)	−0.003 (0.004)	0.001 (0.009)
Market Thickness	0.02*** (0.001)	0.004*** (0.001)	0.007*** (0.001)
Diversification Index	0.011*** (0.006)	0.03** (0.01)	0.04 (0.009)
Competition	0.03 (0.04)	0.12 (0.08)	−0.012 (0.09)
Group	0.01*** (0.005)	0.01*** (0.005)	0.016*** (0.006)
Foreign	−0.004 (0.003)	−0.01** (0.06)	−0.02** (0.01)
No. of obs.	110233	108258	108249
Log likelihood	−27562.18	−37810.58	−44043.48
Chi2	1587.322	1732.537	3456.287
Prob [Chi2 > value]	0.000	0.000	0.000
Random parameters			
d			
Mean	−2.35*** (0.7)	−2.7*** (0.57)	−3.7*** (0.6)
Standard deviation	1.04*** (0.019)	1.3*** (0.02)	1.89*** (0.01)
f			
Mean	−1.12*** (0.3)	−1.21*** (0.2)	−1.8*** (0.3)
Standard deviation	0.78*** (0.01)	0.63*** (0.008)	0.9*** (0.01)

NOTES: ‘Outsourcing ($t - 1$)’ refers to total outsourcing in regression one, to industrial outsourcing in regression two and to the outsourcing of services in regression 3. All regressions include 2-digit industry and time fixed effects, and in all regressions standard errors are bootstrapped. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

5. Results

Table 4 reports the results from the estimation of equation (5). The reported results are marginal effects estimated at the sample’s mean values.¹⁹ The first

¹⁹ The marginal effect of dummy variables is calculated by taking the difference between two probability functions where the dummy variable is equal to one in the first function and equal to

point of interest is the dynamic aspect of the outsourcing decision. Table 4 brings evidence on the persistence of the outsourcing strategy. The outsourcing decision at time t depends significantly on the outsourcing behaviour at time $t - 1$. Outsourcing in time $t - 1$ increases the probability of outsourcing at time t by 20% in the case of total outsourcing, 33% in the case of industrial outsourcing, and 40% in the case of the outsourcing of services.²⁰ The persistence of the outsourcing behaviour may reflect the presence of significant fixed costs associated with outsourcing.

The dynamic aspect of the outsourcing activity has been mostly ignored by the economic literature. To my knowledge, only two other papers have introduced past outsourcing activity as a determinant of firms' present outsourcing decisions. The first is the Girma and Görg (2004) study based on three U.K. manufacturing industries: the chemical industry, the electronic industry, and the mechanical and instrument engineering industry, for the period 1982–1992. Girma and Görg (2004) focus on the intensity of the outsourcing activity and find that past outsourcing activities have a negative and significant effect on current outsourcing. The second is the Díaz-Mora and Triguero (2007) analysis of the outsourcing decision by Spanish manufacturing firms. They find a positive and significant impact of past outsourcing on current outsourcing decisions, but they do not control for firm heterogeneity and do not consider the problems of serial correlation, unobserved fixed effects, and initial conditions related to the estimation of dynamic discrete choice models.

The second point of interest in this paper is the link between firms' characteristics and the outsourcing behaviour. As discussed earlier, both forms of organization imply certain forms of fixed costs and the presence of these costs and their ranking will create a self-selection process. If we assume that the fixed costs associated with outsourcing are higher, this suggests that only the most efficient firms will engage in this strategy. The results in table 4 show that more productive firms and larger ones are more likely to contract-out production. The productivity of firms is positively correlated with the probability of outsourcing. However, this variable may suffer from endogeneity problems and without explicit control of these problems little can be said on the direction of causality. The next section addresses the link between productivity and outsourcing in more detail. Scale is also positively and significantly correlated with outsourcing. As discussed earlier, the size of the firm may have two opposite effects on the outsourcing decision. A positive effect through the reduction of per unit costs of

zero in the second function. The marginal effect of continuous variable is calculated by the derivation of the probability function and setting the value of the regressors at the sample mean. The calculation of the marginal effects sets the value of the heterogeneity terms ϑ_{di} and ϑ_{fi} at zero.

20 These coefficients are consistent with results obtained from the estimation of the dynamic probit model developed by Wooldridge (2005) and from the estimation of an Arellano and Bond (1991) GMM model. The coefficients of the lagged dependent variables in the GMM estimation are 0.25, 0.34, and 0.43 for total outsourcing, industrial outsourcing, the outsourcing of services, respectively. The equivalent marginal effects resulting from the estimation of the Wooldridge (2005) model are 0.19, 0.4, and 0.58.

TABLE 5
Alternative measures of market thickness: marginal effects

	Outsourcing	Industrial	Services
Outsourcing ($t - 1$)	0.2*** (0.05)	0.33*** (0.08)	0.4*** (0.03)
Industry size	0.004*** (0.002)	0.014*** (0.004)	0.02*** (0.003)
Outsourcing ($t - 1$)	0.2*** (0.05)	0.33*** (0.08)	0.4*** (0.03)
Relative size	1.1*** (0.2)	2.33*** (0.7)	2.9*** (0.36)
Outsourcing ($t - 1$)	0.2*** (0.05)	0.33*** (0.08)	0.4*** (0.03)
Relative size-Region	0.12*** (0.07)	0.28*** (0.09)	0.45*** (0.07)
Outsourcing ($t - 1$)	0.2*** (0.05)	0.33*** (0.08)	0.4*** (0.03)
Agglomeration	0.01*** (0.006)	0.01 (0.005)	0.03** (0.01)

search, matching and organization of vertical relationships and a negative one through the presence of economies of scale. The results suggest that the first effect, the positive one, is more substantial.

The third point of interest of this analysis is the impact of market thickness on the outsourcing decision. Table 4 shows that market thickness increases the probability of outsourcing relationships. The effect of market thickness is the largest in the case of the outsourcing of services. These results mean that firms located within regions where the size of the industry is large (in terms of the number of employees) are more likely to contract-out their production. A thicker market reduces search and matching costs and increases the probability of a match and the profitability of outsourcing relationships. Table 5 shows that the positive effect of market thickness is robust to the use of alternative measures of this variable.²¹ All these alternative measures have a positive and significant effect on the probability of outsourcing and this effect is larger in the case of the outsourcing of services. The variable 'Relative Size' has the largest marginal effect. This variable represents the relative size of each 4-digit industry regardless of the regional dimension. This result suggests that French manufacturing firms look for suppliers beyond the limits of their regions.²² The results presented in this paper echo the evidence provided by Holmes (1999) for U.S. industries.

21 The coefficients and marginal effects of the other regressors and the lagged outsourcing status are robust to the choice of the market thickness measure and are similar to the figures presented in table 4.

22 As a robustness check, I have calculated the market thickness variables using the number of firms instead of the number of employees and the results were similar to those presented here. I consider that measuring the market thickness based on the number of employees is more

Holmes (1999) analyzes the link between the geographic localization of industries and the vertical disintegration of production and shows that, in the case of geographically agglomerated industries, vertical disintegration is larger in the geographical centre of the agglomeration. Holmes (1999) also shows a positive correlation between vertical disintegration (measured as the share of purchased inputs in total output) and the geographical size of industries. The main focus of the Holmes (1999) study is on the geographic localization of industries and the presence of agglomeration forces. The differences between this study and the study by Holmes (1999) is the use of firm-level panel data: Holmes (1999) uses data aggregated at the industry and region level and for a single year. The results presented in this paper also confirm the findings presented by Ono (2007) for the outsourcing of business services.

Table 4 displays other results of interest. The positive and significant coefficient on the 'Group' variable indicates that being a member of a group favours outsourcing. Firms affiliated to a parent company may have better access to financial means allowing them to incur the fixed costs associated with outsourcing.²³ Affiliated firms may also face lower search costs because they have a privileged contact with other affiliates of the same group as well as access to the network of specialized suppliers connected to the parent firm. The negative coefficient on the 'Foreign' variable suggests that the positive effect of group affiliation is limited to French group. Foreign affiliates may have limited knowledge of the domestic market, in comparison with domestic affiliates, and may also wish to avoid entering complicated (and incomplete) contractual relationships in a foreign juridical system. Table 4 also shows that firms paying higher wages have a higher probability of outsourcing, but this result is significant only in the case of total outsourcing. Furthermore, firms that have a more diversified production (multi-product firms) seem to have a higher probability of outsourcing but, not in the case of services. At the industry level, the degree of competition has no significant effect on the decision to engage in outsourcing relationships.

Table 6 reports results from the estimation of a Tobit model of outsourcing intensity. Two sets of marginal effects are reported: the first one represents the impact of a change in the regressors on the probability of observing a positive outsourcing activity, while the second represents the impact of this change on the conditional mean of the (censored) dependent variable. Overall, the determinants of the outsourcing intensity are similar to the determinants of the outsourcing decision. More productive firms have a higher probability to engage in outsourcing relationships and to contract-out a larger share of their inputs. Market thickness also has a positive effect on the outsourcing intensity. Two main differences are worth mentioning: the coefficient on the diversification variable is no longer significant and that on the scale variable turns negative in the case of total and industrial outsourcing. Without a theoretical framework it is hard to

accurate. As mentioned earlier, the EAE survey is more representative in terms of number of employees than in terms of the number of firms.

23 Credit constraints may limit the capacity of firms to invest in substantial sunk fixed cost; for example, Manova (2008) shows that credit constraints can hinder firm's export activity.

TABLE 6
Determinants of the outsourcing intensity: a tobit model

	Outsourcing		Industrial		Services	
	Probability of positive outcome	Censored variable	Probability of positive outcome	Censored variable	Probability of positive outcome	Censored variable
TFP	0.078*** (0.002)	0.048*** (0.001)	0.080*** (0.002)	0.037*** (0.001)	0.052*** (0.002)	0.015*** (0.0007)
Scale	-0.002 (0.001)	-0.001 (0.001)	-0.004** (0.002)	-0.002** (0.001)	0.007*** (0.002)	0.002*** (0.0006)
Average Wage	-0.0001 (0.003)	-0.0001 (0.001)	0.004 (0.004)	0.002 (0.001)	0.009** (0.004)	0.003** (0.001)
Market Thickness	0.005*** (0.0004)	0.003*** (0.0002)	0.007*** (0.0005)	0.003*** (0.0002)	0.005*** (0.0005)	0.001*** (0.0001)
Competition	-0.09** (0.043)	-0.058** (0.027)	-0.08 (0.055)	-0.037 (0.026)	-0.04 (0.065)	-0.012 (0.019)
Diversification Index	0.001 (0.003)	0.001 (0.002)	0.002 (0.003)	0.001 (0.002)	-0.003 (0.004)	-0.001 (0.001)
Group	0.01*** (0.001)	0.008*** (0.001)	0.009*** (0.002)	0.004*** (0.001)	0.01*** (0.003)	0.003*** (0.001)
Foreign	-0.001 (0.002)	-0.0007 (0.002)	-0.006* (0.003)	-0.003* (0.002)	-0.015*** (0.004)	-0.004*** (0.001)
No. of obs.	140252	140252	138123	138123	138094	138094
Log Likelihood	42427.768	42427.768	24558.96	24558.96	6130.81	6130.81
Chi2	7496.28	7496.28	7136.05	7136.05	2801.71	2801.71
Prob [Chi2 > value]	0.000	0.000	0.000	0.000	0.000	0.000

NOTES: All regressions include 2-digit industry and time fixed effects, and in all regressions standard errors are bootstrapped. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

interpret these differences. One of the advantages of outsourcing is reduction of the governance costs associated with a large and vertically integrated structure. Large and diversified firms have the experience and know-how to govern large structures. The benefits from intensive outsourcing are probably lower in the case of these firms. Scale provides the firm with the capacity and motivation to engage in outsourcing relationships but they are not associated with an intensive outsourcing activity. Moreover, if the use of material inputs and merchandise, included in the total use of inputs but not considered as outsourcing, increases with the scale of the firm to a larger extent than outsourcing, scale will reduce the outsourcing intensity. Lastly, holding productivity constant, larger firms may lack the level of efficiency necessary to expand their outsourcing activity.

6. Alternative specifications

6.1. Long-term contracts and the persistence of outsourcing

As mentioned above, a positive correlation between past and present outsourcing decisions may reflect the presence of long-term contracts between firms and

TABLE 7
Persistence of the outsourcing strategy: marginal effects

	Outsourcing	Industrial	Services
Outsourcing ($t - 3$)	0.02*** (0.004)	0.05*** (0.01)	0.08*** (0.01)
No. of obs.	100724	98555	98551
Outsourcing ($t - 5$)	0.03*** (0.007)	0.05*** (0.01)	0.05*** (0.01)
No. of obs.	72089	70118	70118
Outsourcing ($t - 8$)	0.03*** (0.01)	0.06*** (0.03)	0.13*** (0.07)
No. of obs.	35388	34288	34288
Outsourcing ($t - 10$)	0.04*** (0.002)	0.08*** (0.03)	0.13*** (0.03)
No. of obs.	15307	14828	14828

suppliers. Firms engage in long-term contracts for a variety of reasons, such as reducing risks, limiting price uncertainties, and minimizing transaction costs in the presence of significant specific investments (Joskow 1987; Li and Kouvelis 1999; Cohen and Agrawal 1999). The duration of a contract may also reflect the time required for the execution of the contracted-out project or task. Firms may also sign long-term contracts in order to avoid the cost associated with renegotiation or with negotiating with and matching new suppliers. In this case, persistence of outsourcing due to fixed costs will be reflected in the choice of long-term outsourcing contracts. The EAE survey reports the total value of contracted-out activity and does not report individual outsourcing transactions. The total outsourcing activity corresponds to a mixture of relationships of different duration, complexity, and nature. The EAE survey does not provide information on the nature of contracts, their duration, or any details on contracted-out inputs, services, or tasks. It is thus difficult to control directly for the duration of contracts or to create proxy variables, such as the degree of asset specificity or the value of the contract, that account for this duration.

In order to present more robust results on the persistence of outsourcing I replicate the estimation of the dynamic probit model presented in equation (5) with different lags of the outsourcing status. The results are reported in table 7. I use three-, five-, eight- and ten-year lags of outsourcing as dependent variables.²⁴ Table 7 shows that the correlation between present and past outsourcing remains positive and significant even after a ten-year time span. Moreover, the effect of past outsourcing experience seem to increase with the time lag. The use of longer lags does not solve the problem of the duration of contracts, especially with the

24 The choice of these lags is ad hoc and aims to represent different time spans within the period of the study.

absence of information on the length of contracts at the firm or industry level, but the evidence presented in figure 1 and tables 1 and 7 suggests that outsourcing is a persistent strategy and that this persistence does not fade with time. Moreover, if firms decide to engage in long-term contracts in order to reduce searching and negotiation costs, this means that firms take into account the extent of fixed costs associated with outsourcing when formulating their contracts. They prefer to spread these costs over a long period and to maintain stable outsourcing relationships in order to avoid incurring these costs again.

6.2. *Productivity and outsourcing: direction of causality*

The direction of causality between certain regressors, such as total factor productivity, average wage, and outsourcing may go in both directions. As discussed above, more productive firms can self-select into outsourcing activities because of the presence of certain fixed costs. Outsourcing may also have an impact on productivity by allowing the firm to specialize and focus on core activities. Thus, Outsourcing may lead to a more efficient allocation of resources within the firm and an improvement of productivity (Abraham and Taylor 1996). Depending on the nature of the contracted-out activities, outsourcing may also have an impact on the wage bill of the firm. If the firm contracts-out low-skill activities, the share of skilled labour in the firm's workforce will increase and the average wage paid by the firm will also increase. Several empirical papers have considered the impact of outsourcing on productivity: Girma and Görg (2004) for the U.K, Görg, Hanley, and Strobl (2008) for Ireland, Paul and Yasar (2009) for Turkey, and Jabbour (2010) for France present a mixture of evidence. The impact of outsourcing on productivity depends on the nature of contracted-out activities (services or material input, high-tech or low-tech inputs), the geographical dimension of outsourcing (domestic or international, developed or developing source countries), and the type of firms (domestic, exporters, or affiliates of multinational firms).

The use of lags, as in equations (5) and (6), may not be sufficient to overcome the endogeneity problem. Firms anticipate their engagement in outsourcing activity and may start to restructure their activities before the beginning of their outsourcing relationships. Moreover, in the presence of serial correlation due to unobserved firm heterogeneity lagged variables are correlated with current error terms. To control for endogeneity issues I estimate two linear instrumental variable models for panel data: one where the dependent variable is the outsourcing status, and the other where the dependent variable is the outsourcing intensity. Valid instruments need to satisfy two conditions; they need to be correlated with the endogenous regressors but exogenous with respect to outsourcing (uncorrelated with the error term) (Wooldridge 2001). As instruments for total factor productivity I use three variables: the R&D intensity at the 3-digit industry level, the intensity in skilled labour at the 4-digit industry level, and the average wage at the 4-digit industry. As instruments for the average wage variable I use the average wage at the 4-digit industry level and the intensity in skilled labour

at the 4-digit industry level.²⁵ Griffith, Harrison, and Van Reenen (2006) and O'Mahony and Vecchi (2009) provide evidence on the presence of knowledge spillovers from R&D investment and human capital investments at the industry level. Because of these knowledge spillover firms active in industries intensive in R&D and human capital experience improvements in their productivity. The choice of industry-level variables as instruments is motivated by their exogeneity with respect to firm-level outsourcing activities. Moreover, these industry-level variables are unlikely to be correlated with the error term because of the omission of certain firm-level unobserved effects. One limitation of the use of industry-level variables is their potential weakness in explaining firm-level variables, but tests of overidentifying restrictions and of the weakness of instruments have confirmed the validity of the chosen set of instruments. Results from instrumental variables models are presented in table 8. A test of the endogeneity of the average wage variable confirmed that this variable is exogenous. In the regressions presented in table 8 only total factor productivity is considered endogenous. In all the regressions, lag of TFP is considered endogenous and instrumented with one-year lags of the share of R&D intensity, skill intensity, and industry-level average wage. The results are robust to the exclusion of the lagged outsourcing status from the set of regressors. The bottom of table 8 presents results of the tests of weakness of the instruments used. The F-statistics represent the joint significance of the instruments, while the remaining statistics correspond to the test developed by Stock and Yogo (2005). The critical values correspond to a tolerated distortion for the 5% Wald test. Both set of tests confirm that the used instruments are valid.²⁶

The results presented in table 8 corroborate the results presented in tables 4 and 6. The coefficients on the lagged dependent variables are larger than those reported in table 4. Random effects linear models overestimate the persistence term because these models do not control for the 'initial conditions' and 'spurious state-dependence' problems (Bernard and Jensen 2004). The coefficient on the TFP variable remains positive and significant but only in the case of outsourcing intensity. When endogeneity is controlled for, TFP is no longer significant in explaining the decision to outsource. More productive firms are not significantly more likely to engage in outsourcing relationships, but, everything else equal, they have a higher intensity of outsourcing. The most significant difference between table 8 and tables 4 and 6 relates to the firm's average wage variable; the coefficient on this variable becomes negative when we explain the intensity of

25 R&D intensity is measured as the ratio of R&D expenditures over value-added. Data on R&D expenditures and value-added at the industry-level are extracted from the OECD statistical resources. Skill intensity is measured as the share of non-production workers in the total wage bill of an industry. Data on the wage bill of production and non-production workers are extracted from the NBER Manufacturing Industry database. The industry-level measure of average wage is calculated by aggregating firm-level measures of average wage at the 4-digit industry level. Details on these variables are available in the appendix.

26 For the purpose of performing these tests I estimate cross-section, linear, IV estimators of the outsourcing status and of the outsourcing intensity.

TABLE 8
Endogenous productivity: instrumental variables models

	Choice			Intensity		
	Outsourcing	Industrial	Services	Outsourcing	Industrial	Services
Outsourcing ($t - 1$)	0.433*** (0.003)	0.456*** (0.003)	0.75*** (0.002)			
TFP	-0.024 (0.046)	-0.02 (0.06)	-0.043 (0.05)	0.511*** (0.093)	0.543*** (0.082)	0.328*** (0.07)
Scale	0.021*** (0.002)	0.016*** (0.002)	0.008*** (0.002)	-0.026*** (0.004)	-0.02*** (0.002)	-0.02*** (0.003)
Average wage	0.032** (0.014)	0.012 (0.018)	0.02 (0.016)	-0.12*** (0.023)	-0.11*** (0.021)	-0.07*** (0.017)
Market Thickness	0.004*** (0.0007)	0.005*** (0.001)	0.003*** (0.0007)	0.008*** (0.0005)	0.007*** (0.0004)	0.008*** (0.0006)
Diversification Index	0.002 (0.009)	0.011 (0.012)	0.0001 (0.01)	0.085*** (0.018)	0.093*** (0.016)	0.055*** (0.013)
Competition	0.075 (0.05)	0.087 (0.05)	0.042 (0.05)	0.069 (0.06)	0.114*** (0.05)	0.054 (0.044)
Group	0.009*** (0.002)	0.009*** (0.002)	0.008*** (0.002)	0.014*** (0.002)	0.01*** (0.002)	0.008*** (0.002)
Foreign	-0.008 (0.005)	-0.01 (0.007)	-0.021*** (0.007)	0.015*** (0.005)	0.019*** (0.005)	0.006* (0.004)
No. of obs.	127536	120007	125013	127357	125363	125334
Wald Chi2	37946.94	90411.06	169551.5	2700.75	3262.86	1676.15
Prob [Chi2 > value]	0.000	0.000	0.000	0.000	0.000	0.000
F-statistic	40.88	42.76	40.85	40.64	41.45	53.54
Prob>F	0.000	0.000	0.000	0.000	0.000	0.000
Min eigenvalue statistic	64.97	66.68	64.27	66.34	66.63	70.11
Critical value (10%)	22.3	22.3	22.3	22.3	22.3	22.3

'Outsourcing ($t - 1$)' refers to total outsourcing in regression one, to industrial outsourcing in regression two, and to the outsourcing of services in regression three. All regressions include 2-digit industry and time fixed effects and in all regressions standard errors are bootstrapped. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

outsourcing. This result suggests that, once we control for the effect of outsourcing on productivity, the average wage variable reflects the skill intensity of the firm and to a certain degree its specific knowledge or capital. Firms intensive in knowledge and with a high degree of asset specificity may be reluctant to engage extensively in outsourcing relationships.

7. Conclusion

Is outsourcing a persistent strategy? Is it associated with substantial organization costs? Are firms engaged in outsourcing relationships subject to state dependence and do their characteristics affect their decision to outsource? Both domestic and international outsourcing are becoming widely adopted strategies among

firms and it is important to understand the economic motivations driving these strategies.

The empirical analysis presented in this paper tries to answer these questions on the basis of a data set of French manufacturing firms for the period 1990–2001. It focuses on the presence of significant costs associated with outsourcing. These costs result from the necessity to search for a partner, to write and enforce contracts, to monitor and control the input's production, and to exchange technology and knowledge with the partner. Because of the presence of these costs, firms may want to make outsourcing a long-term strategy. The presence of substantial costs puts forward the question of firm self-selection into outsourcing. Since some of the outsourcing costs are related to the matching process (searching and finding a partner) the thickness of the market will play a determinant role in the outsourcing decision.

This paper analyzes the outsourcing strategy through the estimation of a dynamic probit model where the outsourcing decision depends on past outsourcing status. In addition to past outsourcing, the paper controls for firm scale and productivity, for market thickness, as well as for a set of control variables at the firm and industry levels. The empirical analysis also controls for the endogeneity of the productivity variable. The results show significant persistence in the outsourcing strategy. The persistence of outsourcing may indicate the presence of significant fixed costs, the prevalence of long-term contracts, or both. The positive effect of scale on the probability of outsourcing corroborates the assumption of high costs related to outsourcing. The results also show that relatively large industries create a favourable environment for outsourcing relationships. A larger industry increases the probability of a match and reduces search costs and provides suppliers with better outside options, thus increasing their willingness to engage in outsourcing relationships. Firms in large industries may benefit from spillovers effects and learn from the outsourcing experience of other firms, raising thereby the profitability of outsourcing.

Appendix: Definition of variables

A.1. Firm-level variables

- Outsourcing activity: Total value of contracted-out goods, equipments, works, and services. This variable also include the outsourcing activities under the 'general outsourcing' and 'other accounts of outsourcing' accounts. Source: The 'EAE' survey.
- Industrial outsourcing activity: Total value of outsourcing where the transactions are recorded as referring to industrial outsourcing. Industrial outsourcing refers to the legal nature of the transaction. According to the definition of industrial outsourcing the buyer is the legal owner of the contracted-out goods or services and has the technical and commercial responsibilities of the contracted-out goods or services. Source: The 'EAE' survey.

- Services outsourcing activity: Total value of contracted-out services. Source: The 'EAE' survey.
- Outsourcing: Dummy variable that takes the value one when the 'outsourcing activity' variable is positive and zero otherwise.
- Industrial outsourcing: Dummy variable that takes the value one when the 'industrial outsourcing activity' variable is positive and zero otherwise.
- Services Outsourcing: Dummy variable that takes the value one when the 'services outsourcing activity' variable is positive and zero otherwise.
- Total use of inputs: This variable is measured as the sum of purchased material, purchased merchandise and contracted-out activity. Purchased material and purchased merchandise are not considered as outsourcing. Source: The 'EAE' survey.
- Outsourcing intensity: This variable is measured as the ratio of 'outsourcing activity' over the 'total use of inputs'.
- Industrial intensity: This variable is measured as the ratio of 'industrial outsourcing activity' over the 'total use of inputs'.
- Services intensity: This variable is measured as the ratio of 'services outsourcing activity' over the 'total use of inputs'.
- Total factor productivity: This variable represents the productivity of the firm. It is measured as an index representing the relative efficiency of the firm in comparison to the average of its industry (2 digits). I follow Aw et al. (2001) and apply the following formula to measure the productivity index:

$$\begin{aligned}
 \ln TFP_{ijt} = & (\ln Y_{ijt} - \overline{\ln Y_{jt}}) + \sum_{s=2}^t \overline{\ln Y_{js}} - \overline{\ln Y_{js-1}} \\
 & - \left[\sum_{x=1}^n \frac{1}{2} (\overline{S_{xijt}} + \overline{S_{xjt}}) (\ln E_{xijt} - \overline{\ln E_{xjt}}) \right. \\
 & \left. + \sum_{s=2}^t \sum_{x=1}^n \frac{1}{2} (\overline{S_{xjs}} + \overline{S_{xjs-1}}) (\overline{\ln E_{xjs}} - \overline{\ln E_{xjs-1}}) \right].
 \end{aligned}$$

Y represents the output of the firm, the set of inputs used by the firm consists of labor, fixed capital and material inputs. Labor is measured as the number of employees and expenditures on labor are measured by the total wage bill of the firm. Fixed capital is measured by the book value of fixed assets and the expenditures on capital are measured as the residual after subtracting the firm's wage bill and use of material inputs from the firm's output.

- Scale: Total number of employees. Source: The 'EAE' survey.
- Average wage: This variable is measured as the ratio of the firm's total wage bill over the total number of employees. Source: The 'EAE' survey.
- Diversification index: This variable represents the scope of the firm's production. It is measured as the inverse of an Herfindahl index of the shares of each

product in the total output of the firm. The following formulas present the calculation of this variable, the index p represents the set of products following the 4-digits classification and the index i represents the firm. The source of this variable is the 'EAE' survey:

$$\text{Market Share Product}_{pit} = \frac{\text{Output}_{pit}}{\sum_p \text{Output}_{pit}}$$

$$\text{Diversification Index}_{it} = \frac{1}{\sum_p \text{MarketShareProduct}_{pit}}.$$

- **Group:** A dummy variable that takes the value one if the firm is controlled by a parent company and zero otherwise. The source of this variable is the 'LIFI' survey.
- **Foreign:** A dummy variable that takes the value one if the firm is controlled by a foreign parent company and zero otherwise. The source of this variable is the 'LIFI' survey.

A.2. Industry-level variables

- **Market thickness:** This variable represents the total size of the firm's 4-digits industry within the same region. Size is measured in terms of employment. The geographical classification follows the administrative decomposition of France into administrative departments. According to this classification metropolitan France accounts for 96 regions. I exclude from the calculation of the size of the 4-digits industry the employment of firm i . The index k represents all firms within industry j except for firm i , index j represents the industry and index r represents the region. The source of this variable is the 'EAE' survey:

$$\text{Market Thickness}_{ijt} = \sum_{k \in jr} \text{Employment}_{kt}.$$

- **Industry size:** This variable represents the total size of the firm's 4-digits industry except for the employment of firm i . The difference between this variable and the 'Market Thickness' one is that the industry size variable does not have a regional dimension. The index k represents all firms within industry j except for firm i . The source of this variable is the 'EAE' survey:

$$\text{Industry Size}_{ijt} = \sum_{k \in jt} \text{Employment}_{kt}.$$

- **Relative size region:** This variable represents the relative size of the firm's 4-digits industry with respect to the size of the manufacturing industry within the same region. Like all other measures of the size of the market, this variable

exclude employment by firm i . The index k represents all firms within industry j and region r except for firm i . The source of this variable is the 'EAE' survey.

$$Relative\ Size\ Region_{ijrt} = \frac{\sum_{k \in jrt} Employment_{kt}}{\sum_{i \in rt} Employment_{it}}.$$

- **Relative size:** This variable represents the relative size of the firm's 4-digits industry with respect to the size of the manufacturing industry in France. The index k represents all firms within industry j except for firm i . The source of this variable is the 'EAE' survey.

$$Relative\ Size_{ijt} = \frac{\sum_{k \in jt} Employment_{kt}}{\sum_i Employment_{it}}.$$

- **Agglomeration:** This variable is a dummy that takes the value one if the firm belongs to an agglomerated 4-digits industry and is located in the region where this industry has its highest share of employment. I construct a measure of agglomeration that follows the methodology developed by Ellison and Glaeser (1997). I also follow Ellison and Glaeser (1997) and consider that an industry is geographically agglomerated if its concentration index is higher than 0.05. The source of this variable is the 'EAE' survey.
- **Concentration index:** the concentration index for each 4-digits industry is constructed using the following formula:

$$Concentration\ Index = \frac{G - \left(1 - \sum_r x_r^2\right) H}{\left(1 - \sum_r x_r^2\right) (1 - H)}. \quad (A1)$$

where r represents a region. x_r represents the share of region r in total manufacturing employment. H is a Herfindahl index of the industry firm size distribution: $H = \sum_i z_i^2$ where z_i is the i th firm share in the employment of the industry. $G = \sum_r (s_r - x_r)^2$ where s_r is the share of the industry employment in region r .

- **Competition:** This variable represents the degree of product market competition within each 4-digits industry. The source of this variable is the 'EAE' survey. It is measured as follows:

$$Competition_{jt} = 1 - \frac{1}{N_{jt}} \sum_{i \in j} \frac{Operating\ Profits_{it}}{Sales_{it}}.$$

A.3. Instrumental variables

- R&D intensity: This is an industry level variable. It is measured as the ratio of R&D expenditures over the value-added of the industry for each 3-digits industry. This variable is calculated using data corresponding to France and is extracted from the OECD statistical sources.
- Skill intensity: This is an industry level variable. It is measured as the share of non-production workers in the total wage of the industry. It is calculated at the 4-digits industry level and is extracted from the NBER Manufacturing Industry database. The construction of this variable uses data corresponding to U.S. industries. Unfortunately, equivalent measures for France were not available. Since France and the U.S. are at comparable levels of development, it is reasonable to assume that the skill intensity of French industries is similar to that of U.S. ones.
- Average industry wage: This is an industry level variable extracted from the 'EAE' survey and measured as the average wage per employee at the 4-digits industry.

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